



A NEW SPECIES OF *CAPNIA* PICTET, 1841 (PLECOPTERA: CAPNIIDAE) FROM KYUSHU, JAPAN, WITH DESCRIPTION OF MALE DRUMMING SIGNALS

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ABSTRACT

A new species of the genus *Capnia* Pictet, 1841, *Capnia mitsuseana* sp. n. (Plecoptera: Capniidae), from Japan is described on the basis of male and female adults, and male drumming signal. Males of the new species are characterized by a modified abdominal tergum 7 with a pair of small tubercles on the anterior margin and with a large tubercle on the posterior margin; a long and rather narrow main epiproct sclerite with a pair of needle-like processes on either side of the tip. Females have abdominal sternum 7 protruding caudally and short subgenital plate that is nearly same length of sternum 8. The males produced monophasic call signals in succession by percussion involving up-down abdominal movements under solitary condition, and the male call signals show horizontal inter-beat interval patterns.

Keywords: *Capnia mitsuseana* Hanada, stonefly, drumming

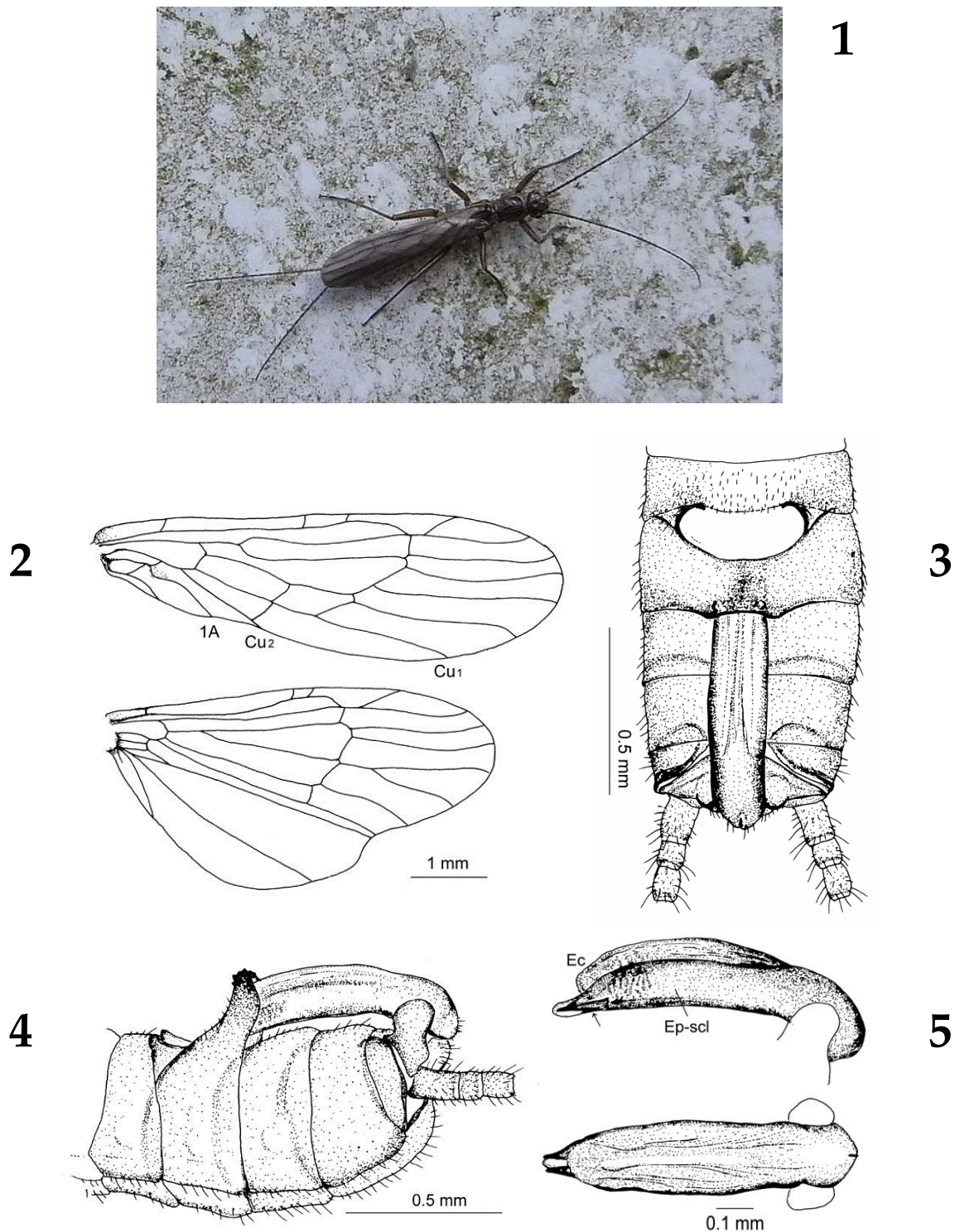
INTRODUCTION

The genus *Capnia* is known as a large genus in Plecoptera and contains more than 100 species (DeWalt et al. 2018). Thirteen species of *Capnia* have been recorded from Japan (DeWalt et al. 2018), and still more undescribed species are known (Shimizu & Negoro 2003). I report a new species of *Capnia* from northern Kyushu, western Japan resulting from studies in the region (Hanada 2014, 2016a, 2016b). I describe the new species based on morphological features of adults and from characteristics of the male vibrational communication signals (drumming), which are known within the infraorder Arctoperlaria as species-specific vibrational signals used for inter-sexual communication.

MATERIALS AND METHODS

Morphological observation. Adults were hand-collected and preserved in 80% ethanol and studied using a Leica MZ12 stereomicroscope (magnification up to 100x). All illustrations were produced using a camera lucida attached to stereomicroscope. The epiproct and the fusion plate used for illustrations were removed from paratype specimens to facilitate illustrations. Female vaginal sclerites were observed and illustrated after abdomens were cleared in a solution of 10% potassium hydroxide (KOH).

All examined materials were collected by Mr. H. Maruyama and the author, and therefore the collector's names were omitted in the materials examined list. The type series will be deposited in



Figs. 1-5. *Capnia mitsuseana* sp. n. 1. Habitus of *Capnia mitsuseana* sp. n. (female). 2. Right wings of *Capnia mitsuseana* sp. n. 3-5. *Capnia mitsuseana* sp. n. (male). 3. Terminalia, dorsal view. 4. Terminalia, lateral view. 5. Epiproct, lateral view (above), dorsal view (below). Ec = eversible crest, Ep-scl = main epiproct sclerite, arrow = needle-like process.

the Lake Biwa Museum, Shiga Prefecture, Japan, and additional materials are deposited in the author's collection.

Recording of drumming signals. Four males collected from the type locality on 16 January and 7 February 2016 were used for recordings of male call signals under solitary condition. These males were kept individually in plastic cylinders with a piece of wet absorbent cotton and lichens from their habitat as food source. The male drumming signals were recorded and analyzed in accordance with the methodology conducted by Hanada (2018). The terminology of drumming signals follows that of Sandberg (2011) and Sandberg et al. (2015).

DESCRIPTION OF SPECIES

Capnia mitsuseana sp. n.

<http://lsid.speciesfile.org/urn:lsid:Plecoptera.speciesfile.org:TaxonName:504342>

(Figs. 1–10)

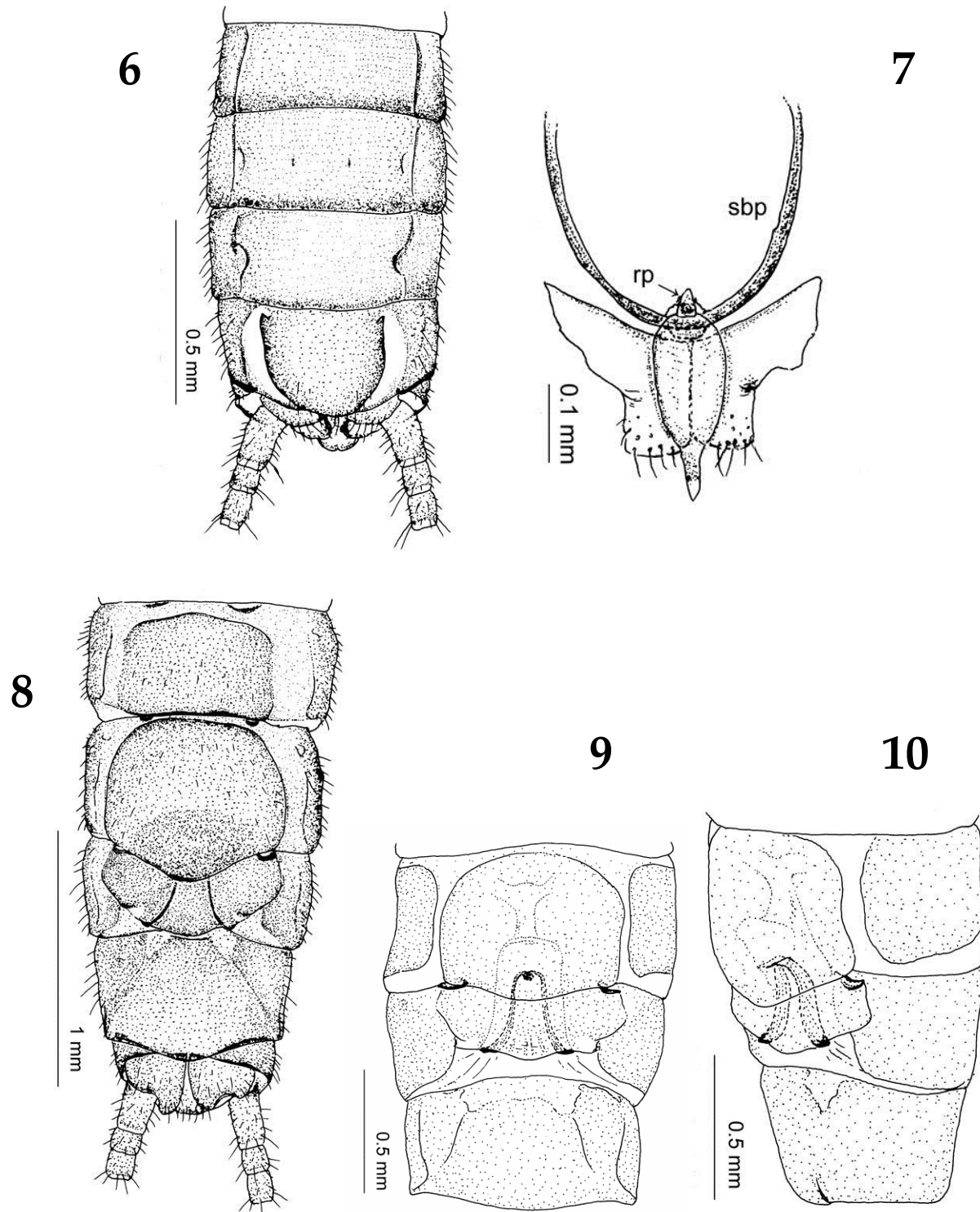
Material examined. Holotype ♂, **Japan:** Iiba, Sawara Ward, Fukuoka City, Fukuoka Prefecture, 33°28.73'N, 130°17.11'E, alt. 480 m, Muromi River, 1.II.2015. Paratypes: 1♀, type locality, 24.I.2015; 4♂, 1♀, type locality, 21.II.2015; 2♂, type locality, 3.I.2016; 4♀, type locality, 21.I.2018.

Additional materials. Japan: Iiba, Sawara Ward, Fukuoka City, Fukuoka Prefecture (type locality), 16.II.2013, 1♂, 1♀; same locality, 23. III.2013, 1♀; same locality, 13.I.2014, 1♂, 1♀; same locality, 22.II.2014, 1♂, 1♀ (copulating pair); same locality, 10.I.2015, 1♀; same locality, 12.I.2015, 1♀; same locality, 18.I.2015, 1♂, 1♀; same locality, 24.I.2015, 4♂, 1♀; same locality, 22.II.2015, 1♂; same locality, 28.II.2015, 1♀; same locality, 3.I.2016, 1♀; same locality, 16.I.2016, 5♂; same locality, 2.II.2016, 2♂, 1♀; same locality, 7.II.2016, 1♂, 1♀; same locality, 28.II.2016, 1♂; same locality, 14.I.2017, 1♀; same locality, 29.I.2017, 1♂; same locality, 2.I.2018, 2♂, 2♀; same locality, 23.II.2018, 2♂, 1♀; same locality, 4.III.2018, 1♀; Magaribuchi, Sawara Ward, Fukuoka City, Fukuoka Prefecture, 33°28.97'N, 130°17.34'E, alt. 410 m, Muromi River, 24.I.2015, 9♂, 5♀; same locality, 31.I.2015, 1♂; same locality, 22.II.2015, 1♂; same locality, 21.II.2016, 1♂; Kumado, Hoshino

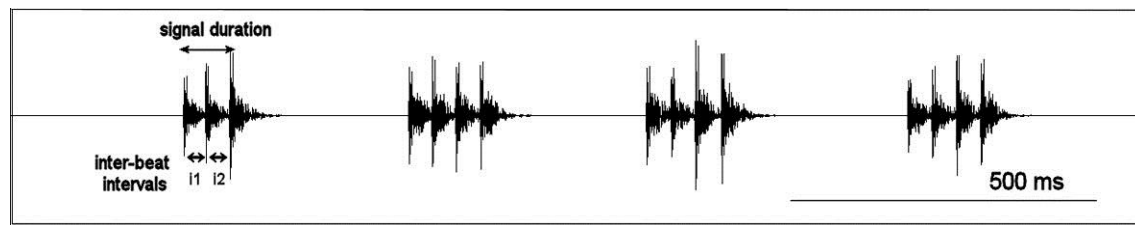
Village, Yame City, Fukuoka Prefecture, 33°13.82'N, 130°50.88'E, alt. 716 m, Kumado River, 25.I.2015, 4♀; same locality, 16.I.2016, 1♀; same locality, 28.II.2016, 1♀; Kamiose, Fuji Town, Saga City, Saga Prefecture, 33°28.22' N, 130°16.21'E, alt. 515 m, Hatsuse River, 7.III.2015, 1♀; same locality, 3.I. 2016, 2♂; same locality, 9.I.2016, 2♂, 1♀; same locality, 30.I.2016, 1♀; same locality, 2.I.2018, 1♂; same locality, 7.I.2018, 1♂; Mitsuse, Mitsuse Town, Saga City, Saga Prefecture, 33°27.91'N, 130°16.47'E, alt. 448 m, Hatsuse River, 16.I.2016, 1♀; same locality, 2.I.2018, 1♀; same locality, 21.I.2018, 1♀; same locality, 23.II.2018, 1♂; Ikisa, Ouchi Town, Karatsu City, Saga Prefecture, 33°22.19'N, 130°02.95' E, alt. 320 m, Saikisa River, 17.III.2018, 1♂; Yoshida, Ureshino City, Saga Prefecture, 33°01.30'N, 130°02.09'E, alt. 460 m, Yoshida River, 29.I.2000, 2♂, 3♀; same locality, 8.III.2000, 1♂.

Adult habitus. Macropterous (Fig. 1), but wing length somewhat variable (forewing length / body length = 0.68–1.17, n = 47 individuals). Wings subhyaline and slightly brownish; veins brown and partly pale. 1A of fore-wing typical to that of *Capnia*, bent abruptly caudad at its junction with cu-a and curved outward again; R₁ of fore-wing typical to that of *Capnia*, bent upward at its origin; Cu₁ and Cu₂ of forewing originating from the different points on arculus (Fig. 2), but rarely from the same point on arculus (11%, n = 46 individuals). General color dark brown. Head, thoracic sclerites and basal segments of abdomen typical to those of *Capnia*. Cerci long, brownish, and composed of 16–26 segments (n = 10 individuals).

Male. Body 4.8–7.0 mm (n = 23) long. Forewing 3.8–6.0 mm (n = 23) long. Tergum 7 modified (Figs. 3 & 4): the anterior margin rising and forming a pair of small and short tubercles with blunt tips; the posterior margin extending upward and forming a large tubercle with a rough, rounded apex bearing sensilla basiconia, the back of which covers the tip of epiproct; membranous field located on antero-middle of tergum 7. The anterior margin of tergum 8 slightly curved posteriorly. Main epiproct sclerite long and rather narrow with a taper, rounded tip in dorsal view; its bottom



Figs. 6–7. *Capnia mitsuseana* sp. n. (male). 6. Terminalia, ventral view. 7. Fusion plate, dorsal view (internal view). rp = retractor plate, sbp = subgenital plate. Figs. 8–10. *Capnia mitsuseana* sp. n. (female). 8. Terminalia, ventral view. 9. Cleared terminalia and inner vaginal sclerites, ventral view. 10. Cleared terminalia and inner vaginal sclerites, ventro-lateral view.



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Fig. 11. A male call signal sequence of *Capnia mitsuseana* sp. n. consisting of four signals. i = inter-beat interval.

nearly straight in lateral view; a pair of needle-like processes located on either side of its tip (Fig. 5). Eversible crest of epiproct swollen in lateral view (Fig. 5). Sternum 9 without a vesicle on the basal margin (Fig. 6). Subgenital plate large and tongue-like shape with a small rounded quadrangular tip; indented basolaterally (Figs. 6 & 7). Fusion plate somewhat shield-shaped, and the anterior margin connected by membrane with a small, subtriangular, sclerotized retractoral plate (Fig. 7). Paraproct with a dilated apex (Fig. 7).

Female. Body 6.0–8.9 mm (n = 24) long. Forewing

5.0–7.2 mm (n = 24) long. Abdominal terga 1 to 8 with broad longitudinal membranous fields along the midline; terga 9 and 10 fully sclerotized. Posterior margin of sternum 7 protruding backward (Fig. 8). Subgenital plate of sternum 8 nearly same length of sternum 8; rounded and having short posteromedial lobe (Fig. 8). A pair of longitudinal inner vaginal sclerites bent ventrally near the anterior ends; curved outward near the posterior ends; visible through the subgenital plate as two longitudinal stripes (Figs. 9 & 10).

Table 1. Male call signal data of *Capnia mitsuseana* sp. n. under solitary condition at 16.8–17.0°C. The values are expressed as mean \pm standard deviation (Mo = mode, n = number of samples) and range. Mean inter-beat interval pattern was determined by mean ID (a maximum – minimum interval difference): H = horizontal interval pattern determined by interval difference (ID) ≤ 10 (Sandberg et al. 2011).

num. of beats	mean inter-beat interval (ms)	inter-beat intervals (ms)			ID & mean inter-beat interval pattern
		i1	i2	i3	
3.7 \pm 0.5 (Mo = 4, n = 43)	39.6 \pm 2.5 (n = 115)	39.1 \pm 2.1 (n = 43)	39.1 \pm 2.0 (n = 43)	40.9 \pm 3.1 (n = 29)	1.8 H
3–4	34.8–53.7	34.8–45.0	36.3–43.5	36.3–53.7	

Drumming signals. Two males (0-day-old and one-day-old after capture) produced signals by percussion involving up-down abdominal movements under solitary condition at 16.8–

17.0°C. Because no female answers were recorded, the call of males is tentatively described as a monophasic signal (Fig. 11). The male call signal was composed of 3.7 \pm 0.5 beats with 39.6 \pm 2.5 ms

mean inter-beat interval (Fig. 11, Table 1). The signal durations averaged 105.8 ms (SD = 21.3, range = 71.1–132.1, n = 43). Interval difference was 1.8 ms ($40.9 - 39.1 = 1.8 \text{ ms} \leq 10 \text{ ms ID}$) (Table 1), and therefore the mean inter-beat interval pattern

was horizontal. The two males always produced series of monophasic signals (Fig. 11). The signal sequence consisted of 3.9 ± 0.5 signals (range = 3–5, mode = 4, n = 11) with 287.7 ± 30.4 ms mean signal interval (range = 220.6–364.3, n = 32).



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Fig. 12. Type locality of *Capnia mitsuseana* sp. n.

Ecological notes. This new species was collected from the upper reaches of rivers (Fig. 14). The emergence period is mainly during winter and early spring (I–III). The adults were found on the parapets of bridges and the guard rails.

Distribution. Japan (northern Kyushu).

Etymology. The specific name *mitsuseana* refers to the Mitsuse Pass where the new species was found.

Remarks. Males of this new species resemble *Capnia asakawana* Kohno, 1952, *C. bituberculata* Uéno, 1929, *C. kibuneana* Kawai, 1957 and *C. fukushimana* Kohno, 1952 in the structure of the modified abdominal tergum 7 where all members of the group displayed a pair of tubercles on the

anterior margin and a large tubercle on the posterior margin (Uéno 1929, Kohno 1952, Kawai 1957). The new species differs from all the others by the anterior tubercles of tergum 7 being smaller and by the main epiproct sclerite being long and rather narrow with a taper, rounded tip in dorsal view and with nearly straight bottom in lateral view. Females of the new species can be distinguished from other Japanese *Capnia* species by abdominal sternum 7 extending caudally over the anterior margin of the 8th sternum and by the short subgenital plate of sternum 8 not extending past the posterior edge of the sternum and by the distinct two longitudinal stripes seen on the

subgenital plate.

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